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DESCRIPTION

HERMETIC COMPRESSOR

TECHNICAL FIELD

The present invention relates to a hermetic compressor for use in a refrigerator, an air conditioner, a freezing refrigerating system or the like.

BACKGROUND ART

In recent years, reduction in consumption power and noise reduction have been strongly demanded with respect to hermetic compressors that are used in freezing systems such as household freezers, refrigerators and so on. Under the circumstances, there have been advanced reduction in viscosity of lubricating oil and reduction in rotation of compressors (e.g. about 1200r/min in case of household refrigerators) by inverter driving. On the other hand, it has been becoming a premise to deal with hydrocarbon refrigerants etc. that are natural refrigerants with low warming coefficients represented by R134a and R600a whose ozone destruction coefficients are zero. Further, a method of a dual support bearing

that supports a shaft at two or more portions, which has been adopted from the past, is effective as an element technology for reducing a sliding loss and reducing vibration and noise upon operation.

As a conventional hermetic compressor, there is one as described in a Laid-open Unexamined Patent Publication No. S61-118571. Hereinbelow, referring to the drawings, description will be given about the foregoing conventional hermetic compressor.

Fig. 8 is a longitudinal sectional view of the conventional hermetic compressor, and Fig. 9 is a plan view of the main part of the conventional hermetic compressor. Figs. 10 and 11 are sectional views of the main parts of the conventional hermetic compressor. In Figs. 8 and 9, 1 denotes a sealed housing, and 2 denotes a space within the sealed housing. The sealed housing 1 receives therein a motor element 5 comprising a stator 3 having a coil portion 3a and a rotor 4, and a compression element 6 driven by the motor element 5. 8 denotes lubricating oil stored within the sealed housing 1.

10 denotes a shaft having a main shaft portion 11 where the rotor 5 is press-fitted and

fixed, and an eccentric portion 12 formed eccentrically to the main shaft portion 11, and further having an auxiliary shaft portion 13 provided coaxially with the main shaft portion. Inside the main shaft portion 11, a concentric pump 14 is provided having one end open into the lubricating oil 8 and the other end communicating with a vertical hole portion 15 that communicates with an upper end portion of the shaft 10. 16 denotes a cylinder block having a compression chamber 17 of a substantially cylindrical shape and a main bearing 18 supporting the main shaft portion 11, and having at an upper portion thereof an auxiliary bearing 19 fixed thereto for supporting the auxiliary shaft portion 13. The auxiliary bearing 19 is provided with a recess portion 19a provided around an outer peripheral portion of the shaft 10. 20 denotes a piston inserted into the compression chamber 17 of the cylinder block 16 so as to be reciprocatingly slidable therein, and coupled to the eccentric portion 12 by a connecting means 21 and a piston pin 22.

With respect to the hermetic compressor thus structured, an operation thereof will be described hereinbelow. The rotor 4 of the motor

element 5 rotates the shaft 10 to transmit rotational motion of the eccentric portion 12 to the piston 20 via the connecting means 21, so that the piston 20 performs reciprocating motion in the compression chamber 17. Following it, refrigerant gas is sucked from a cooling system (not shown) into the compression chamber 17 and compressed therein, then discharged into the cooling system again.

Here, description will be given about a sliding loss reducing mechanism of the dual support bearing. During the operation of the compressor, a compressive load of the piston 20 is transmitted to the eccentric portion 12 via the connecting means 21. Here, inasmuch as the dual support bearing type receives the load at both the upper and lower bearings centering around the eccentric portion 12 (point of application) where the compressive load from the piston 20 is applied, the load is distributed substantially uniformly to the upper and lower bearings, and a face contact is ensured as opposed to the single support bearing type in which a mounting error occurs at the inner periphery, so that load distribution at sliding portions of the shaft 10 becomes uniform to lower the surface pressure, and thus the

sliding length can be shortened as compared with the single support type. As a result thereof, there is provided with a merit that the sliding loss is reduced to achieve improvement in efficiency of the compressor.

Next, description will be given about an oil feed mechanism of the conventional dual support bearing type. In Fig. 10, by rotation of the shaft 10, the lubricating oil 8 in the concentric pump 14 is drawn upward by a centrifugal force forming free surfaces like parabolas A1, A2, flown into the vertical hole portion 15 by a conveying force of the tributary A1, and introduced into the respective sliding portions of the main shaft 11, the eccentric portion 12 and the auxiliary shaft portion 13 in the order named, thereby lubricating them. Further, in Fig. 11, of the lubricating oil 8 drawn up into the vertical hole portion 15, one portion is thrown (direction B) to the sealed housing 1 using as a guide a communication hole 13a provided in the auxiliary shaft portion 13 and the recess portion 19a, and one portion is thrown (direction C) to the sealed housing 1 from an upper end of the vertical hole portion 15. This provides the mechanism in which the lubricating

oil 8 having received the heat from the respective sliding portions can perform the heat radiation to the sealed housing 1 so as to be cooled.

However, in the foregoing conventional structure, inasmuch as the lubricating oil 8 drawn up by the rotation of the shaft 10 is fed to the piston 20 indirectly in the form of air dispersion, the feed amount thereof is unstable. Accordingly, there has been possibility of lowering of reliability such that when the lubricating oil 8 between the piston 20 and the cylinder block 16 becomes insufficient, the amount of leakage of the refrigerant gas from the compression chamber 17 increases to lower the freezing capability or efficiency, or sliding portions between the piston 20 and the cylinder block 16 are subjected to lubrication failure to cause abrasion.

Further, in the foregoing conventional structure, inasmuch as the tip end of the auxiliary shaft portion 13 is located in a position higher than the auxiliary bearing 19 and the cylinder block 16, a portion of the lubricating oil 8 dispersed from the upper end of the vertical hole portion 15 and the communication hole 13a of the auxiliary shaft portion 13 flies over the cylinder block 16 and is splashed on a

suction muffler (not shown) normally located under the compression chamber and, as a result, there has been such an instance where the temperature of the suction muffler increases to raise the temperature of suction gas so that the freezing capability or efficiency is lowered.

Further, in the foregoing conventional structure, upon assembling the compression element 6, it is not possible to assemble the piston 20, the piston pin 22 and the connecting means 21 after fixing the auxiliary bearing 19 to the cylinder block 16, so that the assembling method and order are limited resulting in poor assembling efficiency.

Further, in the foregoing conventional structure, during the operation of the hermetic compressor being stopped, the lubricating oil 8 within the recess portion 19a flows out downward via the communication hole 13a and the vertical hole portion 15 being the oil feed path. Therefore, there has been possibility of lowering of reliability such that, upon starting next, sliding is carried out in a non-oil-feed state until the lubricating oil 8 reaches the auxiliary bearing 19 having a large head difference, and thus sliding portions between the auxiliary shaft

portion 13 and the auxiliary bearing 19 are subjected to lubrication failure to cause abrasion.

Further, in a hermetic motor that is inverter-driven at a plurality of operating frequencies including an operating frequency below a power supply frequency, the foregoing problems are further increased.

DISCLOSURE OF THE INVENTION

The present invention solves the foregoing conventional problems and has an object to provide a hermetic compressor wherein the energy efficiency is high, the noise or vibration during operation is low, the assembling performance is excellent, and further, the reliability is high.

The present invention is configured that a sealed housing stores therein lubricating oil and receives therein a motor element and a compression element driven by said motor element, said compression element comprising a shaft having an eccentric shaft portion, and an auxiliary shaft portion and a main shaft portion coaxially provided on upper and lower sides of said eccentric shaft portion so as to sandwich it therebetween, a cylinder block provided with a compression chamber of a substantially cylindrical

shape, a main bearing fixed to or formed integral with said cylinder block so as to be substantially perpendicular to an axis of said compression chamber and supporting an upper half portion of said main shaft portion of said shaft, an auxiliary bearing fixed to or formed integral with said cylinder block and supporting said auxiliary shaft portion, a piston that performs reciprocating motion in said compression chamber, and connecting means for coupling said piston and said eccentric shaft together, wherein said shaft is provided with an oil feed mechanism having a lower end communicating with said lubricating oil and an upper end penetratingly open to an upper end portion of said auxiliary shaft portion, and at least one of said auxiliary bearing and said cylinder block is provided with an oil feed passage for conducting the lubricating oil discharged from the upper end of said oil feed mechanism, to a sliding surface of said piston. Therefore, the lubricating oil having ascended to the auxiliary shaft portion by means of the oil feed mechanism is dispersed from an upper end portion of the auxiliary bearing by a centrifugal force due to rotation of the shaft, and a portion thereof is splashed on the auxiliary bearing and

stored on an upper surface of the auxiliary bearing. The lubricating oil stored on the upper surface of the auxiliary bearing is stably and continuously fed to the piston and the piston pin from the oil feed passage due to gravity, and thus an action is exhibited that sealing between the piston and the cylinder block is improved, and metal contacts are reduced to lower noise and abrasion caused thereby.

In another mode of the present invention, an oil pool for storing the lubricating oil is further formed concavely in the oil feed passage on the upper surface of the auxiliary bearing. Therefore, an action is exhibited that the lubricating oil once collected in the oil pool can be stably fed to sliding portions of the piston etc.

In another mode of the present invention, an oil dispersion hole communicating with the oil feed mechanism is further formed in a substantially horizontal direction at a portion of the auxiliary shaft portion above the upper surface of the auxiliary bearing. Therefore, an action is exhibited that even when the revolution speed of the shaft or the viscosity of the lubricating oil changes, a direction of the

lubricating oil spouting out from the oil dispersion hole is constant, and thus the dispersed lubricating oil can be easily recovered so that the lubricating oil can be stably fed to the sliding portions of the piston etc.

In another mode of the present invention, an oil fence projecting upward is provided on the upper surface of the auxiliary bearing in the vicinity of the oil feed passage. Therefore, the lubricating oil dispersed from the upper end portion of the auxiliary shaft portion can be hit upon the oil fence so as to be collected on the upper surface of the auxiliary bearing, and thus an action is exhibited that a sufficient amount of the lubricating oil can be stably fed to the sliding portions of the piston etc. Further, an action is exhibited that the oil fence serves as an obstacle to prevent the lubricating oil from being splashed on a suction muffler located below the compression chamber so that the temperature rise of the suction muffler can be prevented.

In another mode of the present invention, an opening portion is further provided, wherein the opening portion communicates with the oil feed passage provided on the upper surface of the auxiliary bearing and is open above an oil feed

passage provided at a portion of the cylinder block above the compression chamber. Therefore, an action is exhibited that the lubricating oil having flown to the lower surface of the auxiliary bearing from the opening portion of the oil feed passage passes through the oil feed passage on the cylinder block, or directly drops to the piston and the piston pin so that the lubricating oil can be stably fed to the sliding portions of the piston etc.

In another mode of the present invention, an oil guide projecting downward is provided in the vicinity of the opening portion on the side of a lower end surface of the auxiliary bearing. Therefore, an action is exhibited that the lubricating oil having flown to the opening portion of the oil feed passage at the lower surface of the auxiliary bearing does not flow in unspecified directions, but drops to the piston and the piston pin along the oil guide, so that the oil feed to the position of the piston pin can be securely and stably carried out.

In another mode of the present invention, a cylindrical piston pin fixed to the piston and coupling a connecting rod being connecting means and the piston together is further provided, and

the opening portion is located right above the piston pin in the vicinity of a bottom dead center of the piston and is larger than a horizontal section of the piston pin. Therefore, when the auxiliary bearing is fixed to the cylinder block in advance, or is formed integral therewith, it is possible to pass the connecting rod through the eccentric portion after inserting the auxiliary shaft into the auxiliary bearing, then insert the piston into the cylinder block, finally insert the piston pin into the piston from an upper portion of the opening portion of the oil feed passage and couple the connecting rod and the piston together, and thus an action is exhibited that the assembling can be carried out in good order so that the working efficiency is improved.

In another mode of the present invention, a cylinder communicating hole having one end communicating with and open to an upper portion in the compression chamber of the cylinder block is provided in the oil feed passage. Therefore, inasmuch as the cylinder communicating hole is almost sealed by the piston, the lubricating oil is retained in the oil feed passage even during being stopped, and thus an action is exhibited that the feed of the lubricating oil to the piston

and the piston pin is started simultaneously with the start-up so that sealing between the piston and the cylinder block is improved, and metal contacts are reduced to lower noise and abrasion caused thereby.

Another mode of the present invention is characterized in that a substantially annular oil feed groove communicating with the oil feed passage in the vicinity of a bottom dead center of the piston is further formed concavely on an outer periphery of the piston. Therefore, the lubricating oil is fed to the oil feed groove when the piston is near the bottom dead center, and the lubricating oil is fed between the piston and the cylinder block during a compression stroke, and thus an action is exhibited that sealing between the piston and the cylinder block is improved, and metal contacts are reduced to lower noise and abrasion caused thereby.

In another mode of the present invention, an oil bath communicating with sliding surfaces between the auxiliary shaft portion and the auxiliary bearing is further formed around the auxiliary shaft portion. Therefore, since a lower portion of the oil bath is almost sealed by the auxiliary shaft portion, the lubricating oil

dispersed from the upper end portion of the auxiliary shaft portion and stored in the oil bath remains in the oil bath even during being stopped so that an action is exhibited that the feed of the lubricating oil to the auxiliary shaft portion is started simultaneously with the start-up, and thus lubricity of the auxiliary shaft portion and the auxiliary bearing immediately after the start-up is improved.

In another mode of the present invention, an oil feed hole is formed on the auxiliary shaft portion, wherein the oil feed hole establishes communication between the oil bath and the oil feed mechanism and has a bottom surface located above a bottom surface of the oil bath. Therefore, an action is exhibited that the lubricating oil can be stably fed to the oil bath from the oil feed hole, and a portion of the lubricating oil remains in the oil bath even during being stopped so that the lubricating oil can be fed to the auxiliary shaft portion constantly stably from the start-up to the stopping.

In another mode of the present invention, a portion of the oil feed passage is formed in the auxiliary bearing, and an oil feed hole establishing communication between the oil feed

passage and the oil feed mechanism at least once during one rotation of the shaft is formed in the auxiliary shaft portion. Therefore, since the lubricating oil having ascended to the auxiliary shaft portion by means of the oil feed mechanism flows directly into the oil feed passage from the oil feed hole, an action is exhibited that even when the revolution speed of the shaft or the viscosity of the lubricating oil changes, the lubricating oil can be stably fed to the piston and the piston pin.

In another mode of the present invention, an oil fence projecting upward is provided on a surface of the cylinder block above the compression chamber, and the oil feed passage is formed in the surface of the cylinder block above the compression chamber. Therefore, an action is exhibited that since the lubricating oil dispersed from the upper end portion of the auxiliary shaft portion can be hit upon the oil fence so as to be collected on the upper surface of the cylinder block, a sufficient amount of the lubricating oil can be stably fed to the sliding portions of the piston etc. and, since the cylinder block is cooled to lower a temperature thereof, the temperature rise of gaseous refrigerant sucked

into the compression chamber is suppressed to reduce a heat receiving loss.

Further, an action is exhibited that the oil fence serves as an obstacle to prevent the lubricating oil from being splashed on a suction muffler located below the compression chamber so that the temperature rise of the suction muffler can be prevented.

In another mode of the present invention, further, it is inverter-driven at a plurality of operating frequencies including at least an operating frequency lower than a power supply frequency. Therefore, an action is exhibited that the consumption power amount is reduced by reduction in compression load due to the low operating frequency.

In another mode of the present invention, further, the operating frequency lower than the power supply frequency includes at least an operating frequency lower than 30Hz. Therefore, an action is exhibited that the consumption power amount can be further reduced by reduction in compression load due to the low operating frequency lower than 30Hz.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a longitudinal sectional view of a hermetic compressor according to an embodiment 1 of the present invention;

Fig. 2 is a plan sectional view of the same embodiment;

Fig. 3 is a sectional view of the main part of the same embodiment;

Fig. 4 is a sectional view of the main part of a hermetic compressor according to an embodiment 2 of the present invention;

Fig. 5 is a sectional view of the main part of a hermetic compressor according to an embodiment 3 of the present invention;

Fig. 6 is a sectional view of the main part of a hermetic compressor according to an embodiment 4 of the present invention;

Fig. 7 is a sectional view of the main part of a hermetic compressor according to an embodiment 5 of the present invention;

Fig. 8 is a longitudinal sectional view of a conventional hermetic compressor;

Fig. 9 is a plan view of the conventional hermetic compressor;

Fig. 10 is a sectional view of a lower portion of a conventional shaft; and

Fig. 11 is a sectional view of the main

part of a conventional auxiliary shaft.

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinbelow, description will be given about embodiments of compressors according to the present invention. The same symbols are assigned to those structures that are the same as the conventional ones, thereby to omit detailed description thereof.

(Embodiment 1)

Fig. 1 is a longitudinal sectional view of a hermetic compressor according to the embodiment 1 of the present invention, and Fig. 2 is a plan sectional view of the same embodiment. Fig. 3 is a sectional view of the main part of the same embodiment.

In Figs. 1, 2 and 3, 101 denotes a sealed housing, and 102 denotes a space within the sealed housing. The sealed housing 101 receives therein a motor element 105 comprising a stator 103 having a coil portion 103a and a rotor 104, and a compression element 106 driven by the motor element 105. The motor element 105 is inverter-driven and can freely change a revolution speed. 108 denotes lubricating oil stored within the sealed housing 101.

110 denotes a shaft having a main shaft portion 111 where the rotor 105 is press-fitted and fixed, an eccentric portion 112 formed eccentrically to the main shaft portion 111, and an auxiliary shaft portion 113 provided coaxially with the main shaft portion 111.

Inside the shaft 110, an oil feed mechanism 114 is provided having one end communicating into the lubricating oil 108 and the other end communicating with an upper end portion of the shaft 110 as a vertical hole portion 115. 116 denotes a cylinder block having a compression chamber 117 of a substantially cylindrical shape and a main bearing 118 supporting the main shaft portion 111, and having at an upper portion thereof an auxiliary bearing 119 fixed thereto for supporting the auxiliary shaft portion 113. 120 denotes a piston inserted into the compression chamber 117 so as to be reciprocatingly slidable therein, and coupled to the eccentric portion 112 by a connecting means 121 and a piston pin 122. 123 denotes a suction muffler having one end communicating with the inside of the compression chamber 117, and the other end communicating with the space 102 within the sealed housing. 124 denotes an opening portion communicating with an

upper surface of the auxiliary bearing 119 and being open above the piston 120.

125 denotes an oil pool formed concavely on the upper surface of the auxiliary bearing 119 for storing the lubricating oil 125. 126 denotes an oil fence formed integral with the auxiliary bearing 119 so as to project upward in the vicinity of the oil pool 125. 127 denotes an oil dispersion hole formed in a substantially horizontal direction at a portion of the auxiliary shaft portion 113 above the upper surface of the auxiliary bearing 119, and communicating with the oil feed mechanism 114.

128 denotes an oil guide projecting downward in the vicinity of the opening portion, on the side of a lower end surface of the auxiliary bearing 119. 129 denotes an oil feed passage for conducting the lubricating oil 108 discharged from the upper end of the oil feed mechanism 114, to a sliding surface of the piston 120, and including the oil dispersion hole 127, the oil pool 125, the oil fence 126, the opening portion 124 and the oil guide 128 in its structure. Further, a portion of the oil feed passage 129 is also formed in the cylinder block 116 over the compression chamber 117.

Refrigerants for use in the present compressor are hydrocarbon refrigerants etc. that are natural refrigerants with low warming coefficients represented by R134a and R600a whose ozone destruction coefficients are zero, and are used in combination with compatible lubricating oils, respectively.

With respect to the hermetic compressor thus structured, an operation thereof will be described hereinbelow.

Through rotation of the shaft 110, the oil feed mechanism 114 has a pump capability generated by a centrifugal force etc., so that the lubricating oil 108 at the bottom portion of the sealed housing 101 is drawn upward passing through the oil feed mechanism 114. As shown in Fig. 3, the lubricating oil 108 drawn up into an upper portion of the vertical hole portion 115 forming an upper portion of the oil feed mechanism 114 is dispersed due to the centrifugal force caused by the rotation of the shaft 110 so as to be splashed on the inner surface of the sealed housing 101 like in the conventional one, while a portion thereof is splashed on the auxiliary bearing 119 and stored in the oil pool 125 formed on the upper surface thereof. The lubricating oil 108 stored

in the oil pool 125 is fed to the piston 120 and the piston pin 122 by directly dropping from the opening portion 124 due to gravity or moving along a wall surface of the cylinder block 116, and further enters between the piston 120 and the cylinder block 116 due to reciprocating motion of the piston 120. Therefore, the sealing performance by the lubricating oil 108 is enhanced so that the amount of leakage of refrigerant gas from the compression chamber 117 into the space 102 within the sealed housing is reduced, thereby improving the freezing capability or efficiency. Further, metal contacts of sliding portions between the piston 120 and the cylinder block 116 and sliding portions of the piston pin 122 are prevented to achieve excellent lubrication, so that the noise caused by the sliding is lowered and the reliability is improved.

Further, by providing the oil fence 126, the lubricating oil 108 dispersed from the upper portion of the auxiliary shaft portion 113 hits the oil fence 126 so as to be collected into the oil pool 125 formed on the upper surface of the auxiliary bearing 119. Therefore, a further sufficient amount of the lubricating oil 108 can be stably fed to the piston 120 and the piston pin

122. Further, by the provision of the oil fence 126, the lubricating oil 108 is not splashed on the suction muffler 123 located under the compression chamber 117, so that the temperature rise of the suction gas following the temperature rise of the suction muffler 123 can be prevented, and thus the freezing capability or efficiency can be enhanced.

Further, by providing the oil dispersion hole 127, even when the revolution speed of the shaft 110 or the viscosity of the lubricating oil 108 is changed, a direction of the lubricating oil 108 spouting out from the oil dispersion hole 127 is stably fixed to a substantially horizontal direction. Therefore, the lubricating oil 108 can be securely hit upon the oil fence 126 so that the lubricating oil 108 can be stably fed to the piston 120 and the piston pin 122.

Further, the lubricating oil 108 having flown to a lower end portion of the opening 124, at the lower surface of the auxiliary bearing 119, of the oil feed passage 129 drops to the piston 120 and the piston pin 122 along the oil guide 128. Therefore, the lubricating oil 108 does not flow in unspecified directions along the lower surface of the auxiliary bearing 119, so that the oil feed

to the sliding surface of the piston or the piston pin can be securely and stably carried out.

When the opening portion 124 of the oil feed passage 129 at the lower surface of the auxiliary bearing 119 and the cylinder block 116 are adjacent to each other, the lubricating oil 108 having flown to the opening portion 124 of the oil feed passage 129 at the lower surface of the auxiliary bearing 119 continuously flows as it is to the cylinder block 116 therealong. Accordingly, as compared with the case of discontinuously dropping in the form of drops, the oil feed to the piston 120 and the piston pin 122 can be continuously and securely carried out, and further, the oil also flows over the surface of the cylinder block 116 to achieve a cooling effect.

In this embodiment, a control is performed such that a relatively high operating frequency such as 60Hz is used initially upon starting to enhance the oil feed capability so as to store the lubricating oil 108 in the oil pool 125, then a low operating frequency such as 25Hz is used for carrying out an energy saving operation depending on a load of the refrigerating cycle.

The action achieved by the foregoing structure is universal irrespective of a kind of

refrigerant and lubricating oil combined therewith.

(Embodiment 2)

Fig. 4 is a sectional view of the main part according to the embodiment 2 of the present invention. A basic structure of a hermetic compressor in this embodiment is the same as the contents shown in Figs. 1 and 2.

In Fig. 4, 130 denotes an opening portion that is provided in an auxiliary bearing 132 as a portion of an oil feed passage 131 leading lubricating oil 108 discharged from an upper end of an oil feed mechanism 114, to a sliding surface of a piston 120, and that is located right above a piston pin 122 in the vicinity of a bottom dead center of the piston 120, and has a section larger than a horizontal section of the piston pin 122.

With respect to the compressor thus structured, an operation thereof will be described hereinbelow.

When the auxiliary bearing is fixed to a cylinder block 116 in advance, or when the auxiliary bearing 132 is formed integral with the cylinder block 116, the order of assembling is such that an auxiliary shaft 113 of a shaft 110 is first passed through a connecting rod 121, and subsequently through the auxiliary bearing 132.

Thereupon, when the piston 120 and the connecting rod 121 are joined together by the piston pin 122, and further, the piston 120 is inserted into the cylinder block 116, the degree of freedom of the connecting rod 121 is small so that insertion of the auxiliary shaft 113 into the auxiliary bearing 132 and insertion of an eccentric portion 112 into the connecting rod 121 should be performed simultaneously, and thus the assembling becomes difficult. However, in the present invention, it is possible to pass the connecting rod 121 through the eccentric portion 112 after inserting the auxiliary shaft 113 into the auxiliary bearing 132, then insert the piston 120 into the cylinder block 116, finally insert the piston pin 122 into the piston 120 from an upper portion of the opening portion of the oil feed passage 131 and couple the connecting rod 121 and the piston 120 together. Therefore, the assembling can be carried out in good order so that the working efficiency is improved.

(Embodiment 3)

Fig. 5 is a sectional view of the main part according to the embodiment 3 of the present invention. A basic structure of a hermetic compressor in this embodiment is the same as the

contents shown in Figs. 1 and 2.

In Fig. 5, 133 denotes a cylinder communicating hole having one end communicating with an oil pool 125, and a lower end communicating with and open to an upper portion in a compression chamber 117 of a cylinder block 116. 134 denotes a substantially annular oil feed groove communicating with the cylinder communicating hole 133 in the vicinity of a bottom dead center of a piston 120 and formed concavely on the outer periphery of the piston 120.

135 denotes an auxiliary bearing fixed to the cylinder block 116 and supporting an auxiliary shaft portion 113. 136 denotes an oil bath communicating with sliding surfaces between the auxiliary shaft portion 113 and the auxiliary bearing 135 and formed around the auxiliary shaft portion 113. 137 denotes an oil feed hole formed on the auxiliary shaft portion 113 for establishing communication between the oil bath 136 and an oil feed mechanism 114, and having a bottom surface located above a bottom surface of the oil bath 136.

138 denotes an oil feed passage for conducing lubricating oil 108 discharged from an upper end of the oil feed mechanism 114, to a

sliding surface of the piston 120, and formed by an oil dispersion hole 127, the oil pool 125, an oil fence 126 and the cylinder communicating hole 133.

With respect to the compressor thus structured, an operation thereof will be described hereinbelow.

Lubricating oil 108 in the oil feed passage 138 flows into the cylinder communicating hole 133, but a lower end portion of the cylinder communicating hole 133 is almost sealed by the piston 120. Accordingly, the lubricating oil 108 remains within the cylinder communicating hole 133 even during being stopped. Therefore, the lubricating oil 108 remaining in the cylinder communicating hole 133 is fed between the piston 120 and the cylinder block 116 simultaneously with the starting so that the sealing between the piston 120 and the cylinder block 116 becomes good immediately after the starting. Thus, the amount of leakage of refrigerant gas from the compression chamber 117 into the space 102 within the sealed housing is lowered so that the freezing capability or efficiency is improved. Further, metal contacts of sliding portions between the piston 120 and the cylinder block 116 and sliding

portions of the piston pin 122, which are liable to occur immediately after the starting, are reduced so that the noise caused by the sliding is lowered and the reliability is improved.

Further, the lubricating oil 108 is fed to the oil feed groove 134 when the piston 120 is near the bottom dead center, and the lubricating oil 108 is fed between the piston 120 and the cylinder block 116 during a compression stroke. By this action, the sealing between the piston 120 and the cylinder block 116 by the lubricating oil 108 is further improved, and the amount of leakage of refrigerant gas from the compression chamber 117 into the space 102 within the sealed housing is further lowered so that the freezing capability or efficiency is improved. Further, metal contacts of the sliding portions between the piston 120 and the cylinder block 116 are further reduced so that the noise caused by the sliding is further lowered and the reliability is further improved.

On the other hand, a portion of the lubricating oil 108 having ascended to the auxiliary shaft portion 113 by means of the oil feed mechanism 114 passes through the oil feed hole 137 to be stored in the oil bath 136, so that

the lubricating oil 108 is fed to sliding surfaces of the auxiliary shaft portion 113 and the auxiliary bearing 135. A lower portion of the oil bath 136 is in the state of being almost sealed by the auxiliary shaft portion 113, and further, the bottom surface of the oil feed hole 137 is located above the bottom surface of the oil bath 136, so that the lubricating oil 108 only slightly flows out from the oil bath 136 during being stopped, and thus remains in the oil bath 136. Therefore, the lubricating oil 108 can be fed to the auxiliary shaft portion 113 simultaneously with the starting, and thus metal contacts of the sliding portions between the auxiliary shaft portion 113 and the auxiliary bearing 135 immediately after the starting are reduced so that the noise caused by the sliding is lowered and the reliability is improved.

Being inverter-driven using low operating frequencies lower than the power supply frequency, it takes the lubricating oil 108 a long time to reach the auxiliary shaft portion 113 upon starting so that a non-oil-feed state is liable to occur during that time. However, in the foregoing structure, inasmuch as the lubricating oil 108 can be fed to the auxiliary shaft portion 113

simultaneously with the starting, the effect is further increased.

Further, like in the case of performing an operation using an extremely low frequency lower than 30Hz after the lubricating oil 108 has been stored in the oil pool 125 and the oil bath 136, even when the pump capability by means of the oil feed mechanism 114 is low so that a long time is required for the lubricating oil 108 to reach the upper end portion of the auxiliary shaft portion 113, the lubricating oil 108 is fed to the auxiliary bearing 135 and the piston 120 from the oil bath 136 and the oil pool 125 during that time, respectively. Therefore, inasmuch as an operation with a lower operating frequency is made possible, the pressure load condition in the freezing system is lightened so that it becomes possible to further reduce the consumption power amount of the compressor.

The action achieved by the foregoing structure is universal irrespective of a kind of refrigerant and lubricating oil combined therewith.

(Embodiment 4)

Fig. 6 is a sectional view of the main part according to the embodiment 4 of the present invention. A basic structure of a hermetic

compressor in this embodiment is the same as the contents shown in Figs. 1 and 2.

In Fig. 6, 139 denotes an oil feed passage for conducting lubricating oil 108 discharged from an upper end of an oil feed mechanism 114, to a sliding surface of a piston 120. A portion of the oil feed passage 139 is formed inside an auxiliary bearing 140, while the oil feed passage 139 further communicates with the inside of a cylinder block 116 and has an open end over the piston 120. 141 denotes an oil feed hole that establishes communication between the oil feed passage 139 and the oil feed mechanism 114 at least once during one rotation of a shaft 110, and is formed in an auxiliary shaft portion 113.

With respect to the compressor thus structured, an operation thereof will be described hereinbelow.

The lubricating oil 108 having ascended to the auxiliary shaft portion 113 by means of the oil feed mechanism 114 flows directly into the oil feed passage 139 from the oil feed hole 141, and thus, even when the revolution speed of the shaft 110 or the viscosity of the lubricating oil 108 is changed, the lubricating oil 108 can be stably and securely fed to the piston 120 and the piston pin

122.

Therefore, the sealing between the piston 120 and the cylinder block 116 is improved, and thus the amount of leakage of refrigerant gas from the compression chamber 117 into the space 102 within the sealed housing is lowered so that the freezing capability or efficiency is improved. Further, metal contacts of sliding portions between the piston 120 and the cylinder block 116 and sliding portions of the piston pin 122, which are liable to occur immediately after the starting, are reduced so that the noise caused by the sliding is lowered and the reliability is improved.

(Embodiment 5)

Fig. 7 is a sectional view of the main part according to the embodiment 5 of the present invention. A basic structure of a hermetic compressor in this embodiment is the same as the contents shown in Figs. 1 and 2.

In Fig. 7, 142 denotes an oil fence formed so as to project upward on a surface of a cylinder block 116 above a compression chamber 117, and 143 denotes an oil feed passage for conducting lubricating oil 108 discharged from an upper end of an oil feed mechanism 114, to a sliding surface of a piston 120, wherein a portion thereof is

formed in the surface of the cylinder block 116 above the compression chamber 117. 144 denotes an auxiliary bearing fixed to the cylinder block 116 and supporting an auxiliary shaft portion 113.

With respect to the compressor thus structured, an operation thereof will be described hereinbelow.

A portion of the lubricating oil 108 having ascended to the auxiliary shaft portion 113 by means of the oil feed mechanism 114 is dispersed from an upper end portion of the auxiliary shaft portion 113 to hit the oil fence 142 and flows over an upper surface of the cylinder block 116 along the oil feed passage 143 so as to be fed to the piston 120 and a piston pin 122. In this event, since the cylinder block 116 is cooled by the lubricating oil 108 to lower a temperature thereof, the temperature rise of gaseous refrigerant sucked into the compression chamber 117 is suppressed to reduce a heat receiving loss, so that the freezing capability or efficiency is increased. Further, it is possible to prevent seizure etc. of sliding portions between the piston 120 and the cylinder block 116 owing to the lowering of temperature of the cylinder block 116, so that the reliability is improved.

Further, by the provision of the oil fence 142, there is almost no lubricating oil 108 that is splashed on the suction muffler 123 located below the compression chamber 117, so that the temperature rise of suction gas following the temperature rise of the suction muffler 123 can be prevented, and thus the freezing capability or efficiency can be enhanced.

INDUSTRIAL APPLICABILITY

As described above, the present invention is configured that the shaft is provided with an oil feed mechanism having a lower end communicating with the lubricating oil and an upper end penetratingly open to an upper end portion of the auxiliary shaft portion, and at least one of the auxiliary bearing and the cylinder block is provided with an oil feed passage for conducting the lubricating oil discharged from the upper end of the oil feed mechanism, to a sliding surface of the piston. Therefore, the lubricating oil is stably fed to the piston and the piston pin from the oil feed passage, so that the freezing capability or efficiency is improved, the noise caused by the sliding of the piston and the piston pin is

lowered, and the reliability is further improved.

In another mode of the present invention, an oil pool for storing the lubricating oil is further formed concavely in the oil feed passage on the upper surface of the auxiliary bearing. Therefore, a sufficient amount of the lubricating oil can be stably fed to the piston, so that the freezing capability or efficiency is improved, the noise caused by the sliding of the piston and the piston pin is lowered, and the reliability is further improved.

In another mode of the present invention, an oil dispersion hole communicating with the oil feed mechanism is further formed in a substantially horizontal direction at a portion of the auxiliary shaft portion above the upper surface of the auxiliary bearing. Therefore, even when the revolution speed of the shaft or the viscosity of the lubricating oil changes, a direction of the lubricating oil spouting out from the oil dispersion hole is constant, and thus the dispersed lubricating oil can be easily recovered. Thus, the lubricating oil can be stably fed to the piston and the piston pin, so that the freezing capability or efficiency is improved, the noise caused by the sliding of the piston and the piston

pin is lowered, and the reliability is further improved.

In another mode of the present invention, an oil fence projecting upward is provided on the upper surface of the auxiliary bearing in the vicinity of the oil feed passage. Therefore, the lubricating oil can be collected on the upper surface of the auxiliary bearing, so that a sufficient amount of the lubricating oil can be stably fed to the piston, and further, the temperature rise of suction gas following the temperature rise of a suction muffler due to the lubricating oil can be prevented. Accordingly, the freezing capability or efficiency is improved, the noise caused by the sliding of the piston and the piston pin is lowered, and the reliability is further improved.

In another mode of the present invention, an opening portion is provided, wherein the opening portion communicates with the oil feed passage provided on the upper surface of the auxiliary bearing and is open above an oil feed passage provided at a portion of the cylinder block above the compression chamber. Therefore, the lubricating oil drops to the piston and the piston pin via the oil feed passage on the

cylinder block or directly to enable the oil feed, so that the oil feed to the piston and the piston pin can be securely carried out, and a cooling effect is obtained by the lubricating oil flowing on the surface of the cylinder block. Accordingly, the freezing capability or efficiency is improved, the noise caused by the sliding of the piston and the piston pin is lowered, and the reliability is further improved.

In another mode of the present invention, an oil guide projecting downward is provided in the vicinity of the opening portion on the side of a lower end surface of the auxiliary bearing. Therefore, the oil feed can be securely and stably implemented relative to the sliding portions of the piston as aimed, so that the freezing capability or efficiency is improved, the noise caused by the sliding of the piston and the piston pin is lowered, and the reliability is further improved.

In another mode of the present invention, a cylindrical piston pin fixed to the piston and coupling a connecting rod being connecting means and the piston together is further provided, and the opening portion is located right above the piston pin in the vicinity of a bottom dead center

of the piston and is larger than a horizontal section of the piston pin. Therefore, when the auxiliary bearing is fixed to the cylinder block in advance, or is formed integral therewith, the assembling is easy because it is not necessary to simultaneously perform the insertion of the auxiliary shaft into the auxiliary bearing and the insertion of the eccentric portion into the connecting rod, so that the assembling can be carried out in good order, and thus the working efficiency is improved.

In another mode of the present invention, a cylinder communicating hole having one end communicating with and open to an upper portion in the compression chamber of the cylinder block is provided in the oil feed passage. Therefore, the amount of leakage of refrigerant gas from the compression chamber is reduced immediately after the start-up to improve the freezing capability or efficiency. Further, metal contacts of the sliding portions of the piston and the piston pin are prevented immediately after the start-up to provide excellent lubrication, so that the noise caused by the sliding is lowered and the reliability is improved.

Another mode of the present invention is

characterized in that a substantially annular oil feed groove communicating with the oil feed passage in the vicinity of a bottom dead center of the piston is further formed concavely on an outer periphery of the piston. Therefore, following the improvement in sealing performance, there are obtained effects in improvement of the freezing capability or efficiency and improvement of the reliability of the sliding portions.

In another mode of the present invention, an oil bath communicating with sliding surfaces between the auxiliary shaft portion and the auxiliary bearing is further formed around the auxiliary shaft portion. Therefore, the lubricating oil can be fed to the auxiliary shaft portion simultaneously with the start-up, and thus the lubrication of the sliding portions between the auxiliary shaft portion and the auxiliary bearing is made excellent, so that the noise caused by the sliding is lowered and the reliability is improved.

In another mode of the present invention, an oil feed hole is formed on the auxiliary shaft portion, wherein the oil feed hole establishes communication between the oil bath and the oil feed mechanism and has a bottom surface located

above a bottom surface of the oil bath. Therefore, the lubricating oil can be fed to the auxiliary shaft portion constantly stably from the start-up to the stopping.

In another mode of the present invention, a portion of the oil feed passage is formed in the auxiliary bearing, and an oil feed hole establishing communication between the oil feed passage and the oil feed mechanism at least once during one rotation of the shaft is formed in the auxiliary shaft portion. Therefore, even when the revolution speed of the shaft or the viscosity of the lubricating oil changes, the lubricating oil can be stably fed to the sliding surfaces between the auxiliary shaft portion and the auxiliary bearing, the piston and the piston pin.

In another mode of the present invention, an oil fence projecting upward is provided on a surface of the cylinder block above the compression chamber, and the oil feed passage is formed in the surface of the cylinder block above the compression chamber. Therefore, a heat receiving loss is reduced so that the freezing capability or efficiency is increased and the reliability is improved. Further, the temperature rise of suction gas following the temperature rise

of the suction muffler can be prevented so that the freezing capability or efficiency is enhanced.

In another mode of the present invention, further, it is inverter-driven at a plurality of operating frequencies including at least an operating frequency lower than a power supply frequency. Therefore, the consumption power amount of the compressor is reduced.

In another mode of the present invention, further, the operating frequency lower than the power supply frequency includes at least an operating frequency lower than 30Hz. Therefore, inasmuch as the operation at a lower operating frequency is made possible, the consumption power amount is further reduced.